UNIVERSITI SAINS MALAYSIA

First Semester Examination
2013/2014 Academic Session

December 2013/January 2014

EEE 228 – SIGNAL AND SYSTEM
[ISYARAT DAN SISTEM]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of THIRTEEN (13) pages and Appendices TWELVE (12) of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi TIGA BELAS (13) mukasurat dan Lampiran DUA BELAS (12) muka surat bercetak sebelum anda memulakan peperiksaan ini.]

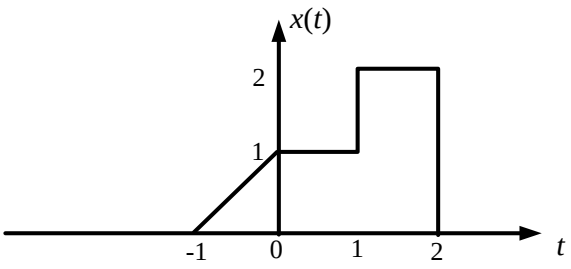
Instructions: This question paper consists of SIX (6) questions. Answer **FIVE** (5) questions. All questions carry the same marks.
[***Arahan:*** *Kertas soalan ini mengandungi ENAM (6) soalan. Jawab **LIMA** (5) soalan. Semua soalan membawa jumlah markah yang sama.]*

Answer to any question must start on a new page.
[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru]

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

…2/-

1. (a) Satu isyarat *x*(*t*) yang ditunjukkan dalam Rajah 1(a)
A signal x(t) is shown in Figure 1(a)



Rajah 1(a)
Figure 1(a)

Lakar dan label isyarat berikut
Sketch and label the following signal

$$y(t) = [2x(2t-1)-1]u(2-t)$$

(lakaran bebas dibenarkan)
(freehand sketch is allowed)

(20 markah/*marks*)

(b) Plot isyarat berikut
Plot the following signal

$$x(t) = r(t-1) - r(t) + u(t-1)$$

Dan juga plot
And also plot

$$y(t) = \frac{dx(t)}{dt}$$

(20 markah/*marks*)

…3/-

(c) Mana-mana isyarat $x(t)$ boleh dinyatakan sebagai $x(t) = x_e(t) + x_o(t)$; dimana $x_e(t)$ dan $x_o(t)$ adalah genap dan ganjil sebahagian daripada isyarat masing-masing

Any signal $x(t)$ can be expressed as $x(t) = x_e(t) + x_o(t)$; where $x_e(t)$ and $x_o(t)$ are even and odd part of the signal respectively.

Tunjukkan bahawa
Prove that

$(i) \quad x_e(t) = \frac{1}{2}\{x(t) + x(-t)\}$

$(ii) \quad x_o(t) = \frac{1}{2}\{x(t) - x(-t)\}$

(20 markah/*marks*)

(d) Tentukan sama ada isyarat berikut adalah isyarat tenaga atau kuasa isyarat atau tidak

Determine whether the following signal is energy signal or power signal or neither.

$$x(t) = e^{-at}u(t), \qquad \text{for } a > 0$$

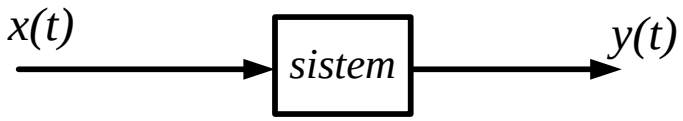
(20 markah/*marks*)

(e) Nilaikan kamiran berikut
Evaluate the following integrals

$$\int_{-4}^{4} (t-2)^2 u(2-t)\delta(2t-2)dt$$

(20 markah/*marks*)

2. (a)



Rajah 2(a)

Figure 2(a)

Sistem yang ditunjukkan dalam Rajah 2(a) mempunyai x (t) sebagai input dan y (t) sebagai output dan sistem digambarkan oleh berikut

The system shown in Figure 2(a) has x(t) as the input and y(t) as output and the system is described by the following

$$y(t) = \int_{-\infty}^{2t} x(\tau) d\tau$$

Tentukan sama ada sistem ini,

Determine whether the system is,

(i) linear

linear

(ii) masa-varian

time-variant

(iii) punca

causal

(25 markah/*marks*)

(b) Jika input sistem LTI ialah $x(t) = e^{-3t}u(t)$ dan sambutan dedenyut sistem adalah $h(t) = \delta(2t+3)$, cari sistem keluaran sistem tersebut.

If the input of an LTI system is $x(t) = e^{-3t}u(t)$ *and the impulse response of that system is* $h(t) = \delta(2t+3)$*, determine the output of the system*

(25 markah/*marks*)

(c) Satu sistem dinyatakan oleh persamaan pembezaan berikut

A system is described by the following differential equation

$$\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} = \frac{dx(t)}{dt} + 4x(t)$$

Cari sambutan denyut *h*(*t*) daripada sistem ini

Find the impulse response h(t) of the system

(25 markah/*marks*)

(d) Lukiskan gambarajah simulasi untuk sistem yang diwakili oleh

Draw a simulation diagram for the system represented by

$$\frac{d^3y(t)}{dt^3} - 2\frac{dy(t)}{dt} + y(t) = \frac{d^2x(t)}{dt^2} + 2x(t)$$

(25 markah/*marks*)

3. (a) Tentukan pekali eskponensial Fourier isyarat berkala berikut.

Determine the exponential Fourier coefficients of the following periodic signal.

$$x(t) = 3 + 5\cos(2t + 30°) + 2\sin(4t - 10°)$$

Juga tentukan jumlah kuasa isyarat berkala

Also determine the amount of power of the periodic signal

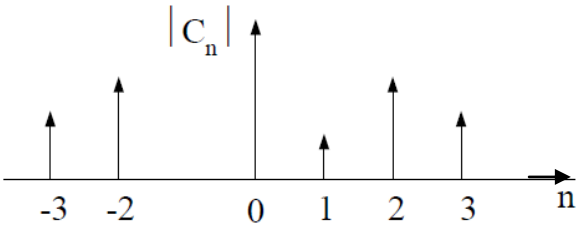
(30 markah/*marks*)

(b) Jelaskan mengapa perwakilan isyarat berikut bukan siri Fourier sah

Explain why the following signal representations are not valid Fourier series

(i) $x(t) = 4\sin(-2\pi t + 30°) + (4 + 2j)\cos(2\pi t) + 4\sin(8\pi t)$

(ii)



Rajah 3(b)

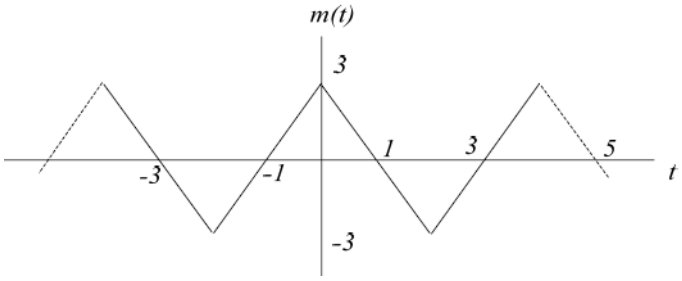
Figure 3(b)

(20 markah/*marks*)

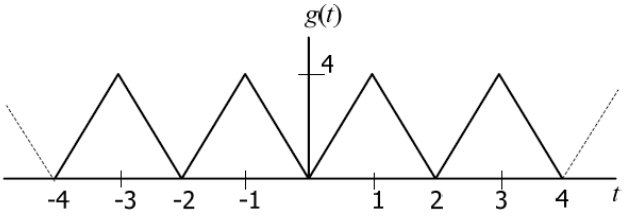
(c) Ulas mengenai komponen eksponensial siri Fourier, [C_0 dan C_n] untuk isyarat yang ditunjukkan dalam Rajah 3(c), (sama ada wujud atau tidak, jika wujud, genap / ganjil dan nyata / khayalan / kompleks)

Comment on the exponential Fourier series components, [C_0 and C_n] for the signals shown in Figure 3(c), (whether exist or not, and if exist, comment on the even/odd and real/imaginary/complex)

(i)



(ii)



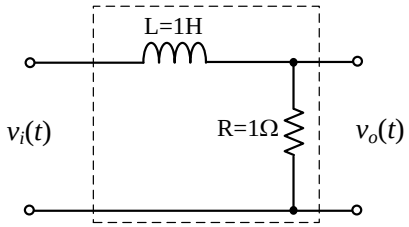
Rajah 3(c)

Figure 3(c)

(25 markah/*marks*)

(d) Cari voltan keluaran $v_o(t)$ bagi litar yang ditunjukkan dalam Rajah 3(d) untuk voltan input berkala $v_i(t)$

Find the output voltage $v_o(t)$ of the circuit shown in Figure 3(d) for a periodic input voltage $v_i(t)$



$v_i(t)= 4 \cos(t) - 2\cos(2t)$

Rajah 3(d)

Figure 3(d)

(25 markah/*marks*)

4. (a) Dengan menggunakan definisi jelmaan Fourier, terbitkan jelmaan Fourier untuk:

Using the definition of Fourier Transform, derive the Fourier Transform of

$$x = e^{-bt}u(t), b > 0$$

(25 markah/*marks*)

(b) Tentukan Jelmaan Fourier bagi isyarat domain masa berikut:
Determine the Fourier Transform of the following time-domain signals:

(i) $f(t) = 2rect\left(\frac{t-0.5}{1}\right) * rect\left(\frac{t-1.5}{3}\right)$

(ii) $g(t) = Asin(\omega_1 t) + Bcos(\omega_2 t)$

(35 markah/*marks*)

(c) (i) Dengan menggunakan Fourier Transform cari sambutan dedenyut, *h(t)* bagi sistem berikut:

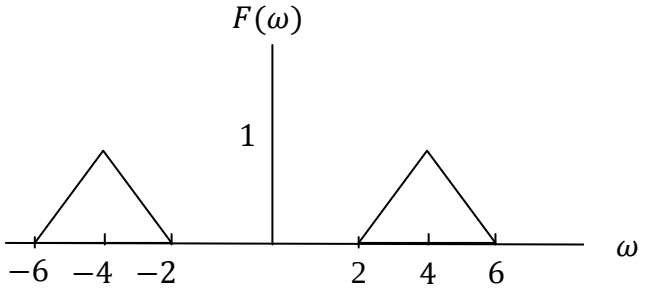
By using Fourier Transform, determine the impulse response, h(t) for the system:

$$y'(t) + 2y(t) = x(t) + x'(t)$$

(ii) Dengan menggunakan ciri-ciri dan jadual yang sesuai, cari Jelmaan Songsang Fourier bagi spektra di dalam Rajah 4(c).

By using appropriate properties and table, determine the Inverse Fourier Transform of the spectra in Figure 4(c).

(40 markah/*marks*)



Rajah 4(c)

Figure 4(c)

5. (a) (i) Tentukan keadaan sambutan sifar bagi sistem LTID dengan fungsi pindah

Determine the zero state response of LTID system with transfer function

$$H[z] = \frac{2z + 3}{(z - 2)(z - 3)}$$

Diberi
Given that

$$f[k] = u[k]$$

(ii) Tentukan jelmaan z songsang bagi fungsi berikut
Determine the inverse z-transform of the given function

$$X(z) = \frac{1}{1 - 1.5z^{-1} + 0.5z^{-2}}$$

(30 markah/*marks*)

(b) Diberi bahawa, $(\cos \Omega n)x[n] = \frac{1}{2}\left[e^{-j\Omega}x[n] + e^{j\Omega}x[n]\right]$, buktikan bahawa

$(\cos \Omega n)u[n] \leftrightarrow \frac{z^2 - (\cos \Omega)z}{z^2 - (\cos \Omega)z + 1}$

Given that $(cos\ \Omega n)x[n] = \frac{1}{2}\left[e^{-j\Omega}x[n] + e^{j\Omega}x[n]\right]$, *prove that*

$(cos\ \Omega n)u[n] \leftrightarrow \frac{z^2 - (cos\ \Omega)z}{z^2 - (cos\ \Omega)z + 1}$

(30 markah/*marks*)

(c) (i) Terangkan secara ringkas apakah teori persampelan dan kadar Nyquist.

Explain briefly what are sampling theorem and Nyquist rate.

(10 markah/*marks*)

(ii) Cari frekuensi minimum persampelan yang boleh digunakan untuk memperolehi sampel isyarat berikut:

Find the minimum sampling frequency that can be used to obtain samples of this signal:

$$x(t) = sinc^2(100\pi t)$$

Plot isyarat ideal tersampel dan frekuensi spektra bagi isyarat pada frekuensi persampelan 50, 200 dan 300 Hz.

Plot the ideally sampled signal and its frequency spectrum for the signal for sampling frequencies of 50, 200 and 300 Hz.

(30 markah/*marks*)

6. (a) Selesaikan
Solve

$$y[k+2] - 2y[k+1] + 2y[k] = f[k]$$

Dengan
With

y[-1]=1, y[-2]=0 and f[k]=u[k]

(40 markah/*marks*)

(b) Kirakan 4-titik dan 8 titik DFT bagi tiga jujukan sampel yang diberi oleh:
Compute 4-point and 8-point DFT of three sample sequence given by:

$$x(n) = \begin{cases} \frac{1}{3} & ; 0 \le n \le 2 \\ 0; \text{lain} - \text{lain}/else \end{cases}$$

Dengan definisi titik N DFT, X(k) for 0 ≤ k ≤ N-1 diberi oleh
By the definition of N-point DFT, the X(k) for 0 ≤ k ≤ N-1 is given by

$$X(k) = \sum_{n=0}^{N-1} x(n) e^{-\frac{j2\pi kn}{N}}$$

(60 markah/*marks*)

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